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Sugimoto et al.

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(45) **Date of Patent: Mar. 19, 2002**

(54) **HEAT EXCHANGER HAVING HEADER TANK**

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(51) **Int. Cl.**[7] **F28F 9/02**

(52) **U.S. Cl.** **165/173**; 165/906

(58) **Field of Search** 165/173, 906; 29/890.052

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,866,675 A	*	2/1975	Bardon et al.	165/173
5,193,613 A	*	3/1993	Wallis	165/173
5,492,172 A	*	2/1996	Laveran et al.	165/173
D373,417 S	*	9/1996	Lee	D23/386
5,579,833 A	*	12/1996	Wijkstrom	165/173
6,056,047 A	*	5/2000	Gowan	165/174
6,167,953 B1	*	1/2001	Kobayashi et al.	165/173

FOREIGN PATENT DOCUMENTS

JP	U-58-154389	10/1983
JP	A-10-267588	10/1998

* cited by examiner

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(57) **ABSTRACT**

A radiator has plural metal tubes and a metal header tank. The header tank has plural connection portions each of which is connected to each of the tubes, and plural reinforcement ribs formed opposite the connection portions at a non-connection portion of the header tank to which no tube is connected. The reinforcement ribs and the connection portions are arranged in a longitudinal direction of the header tank at substantially the same pitch, so that each of the reinforcement ribs is disposed opposite each of the connection portions. Therefore, a rigidity of the non-connection portion is increased by the reinforcement ribs, and an internal pressure of the header tank is restricted from being intensively applied to the non-connection portion. As a result, a mechanical strength of the header tank is sufficiently increased without increasing a thickness of a metal plate from which the header tank is formed.

24 Claims, 12 Drawing Sheets

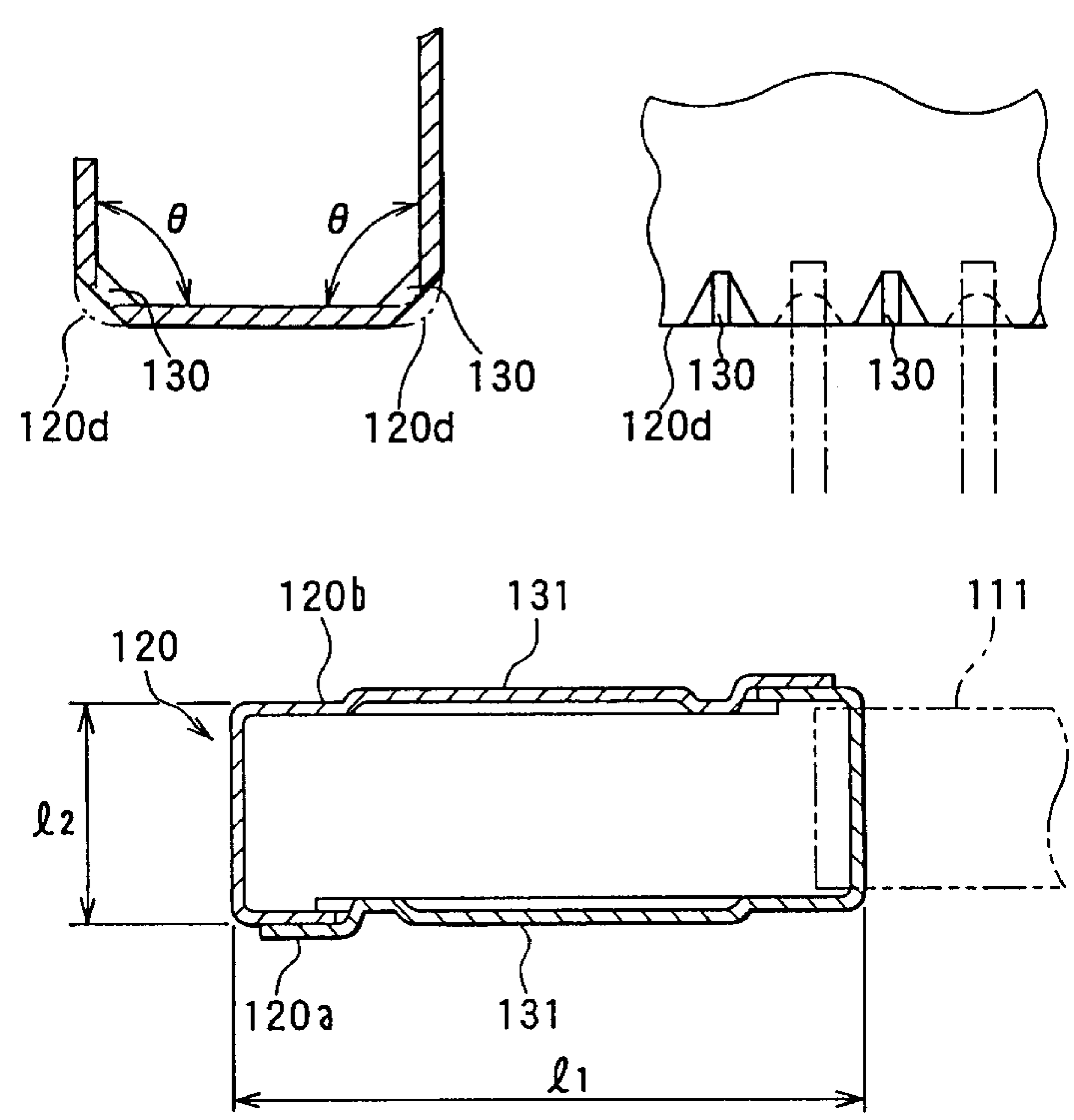
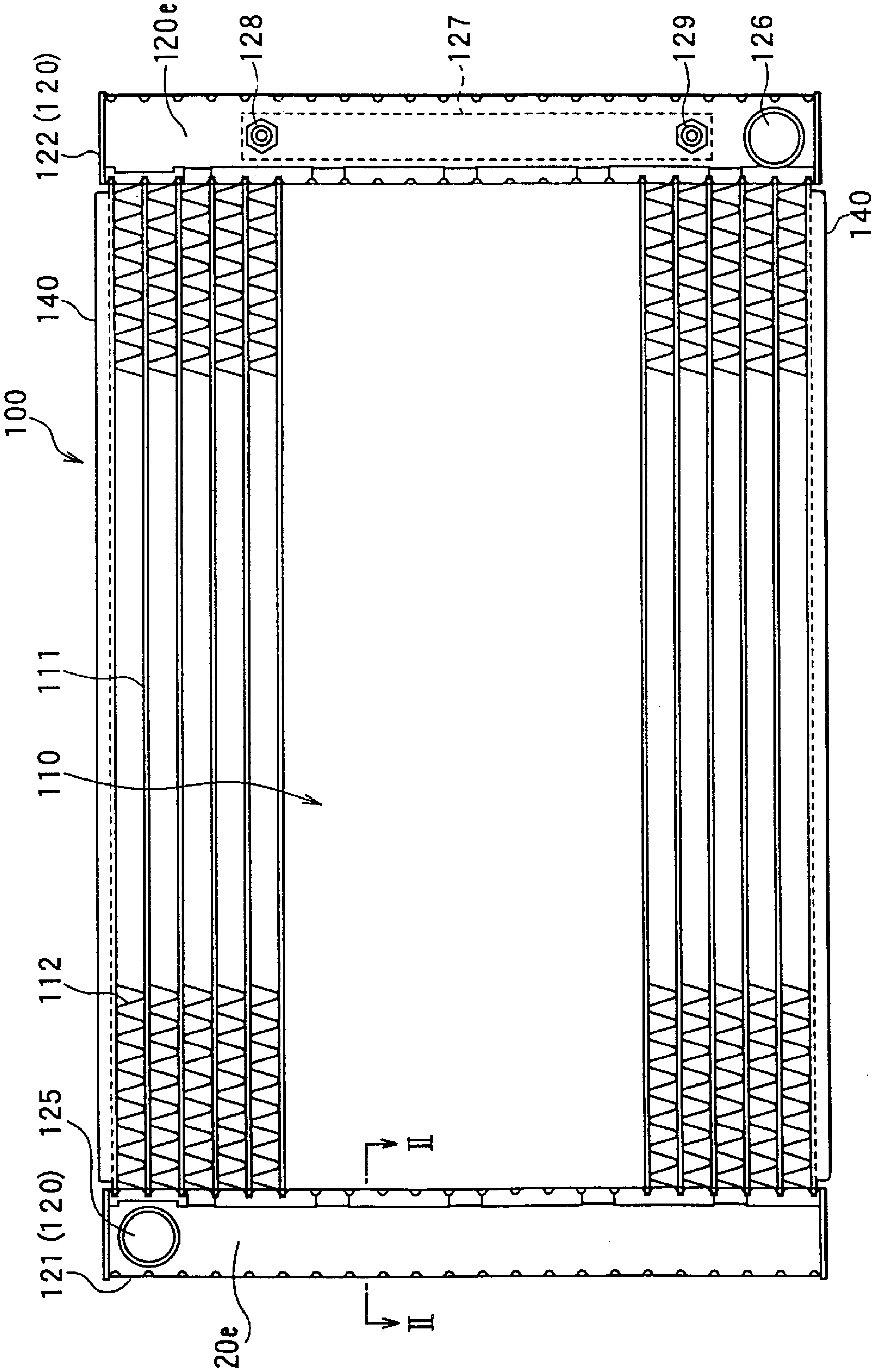


FIG. 1


120e
128
127
129
126
122 (120)
140
140
100
111
110
112
125
121 (120)
120e
II
II

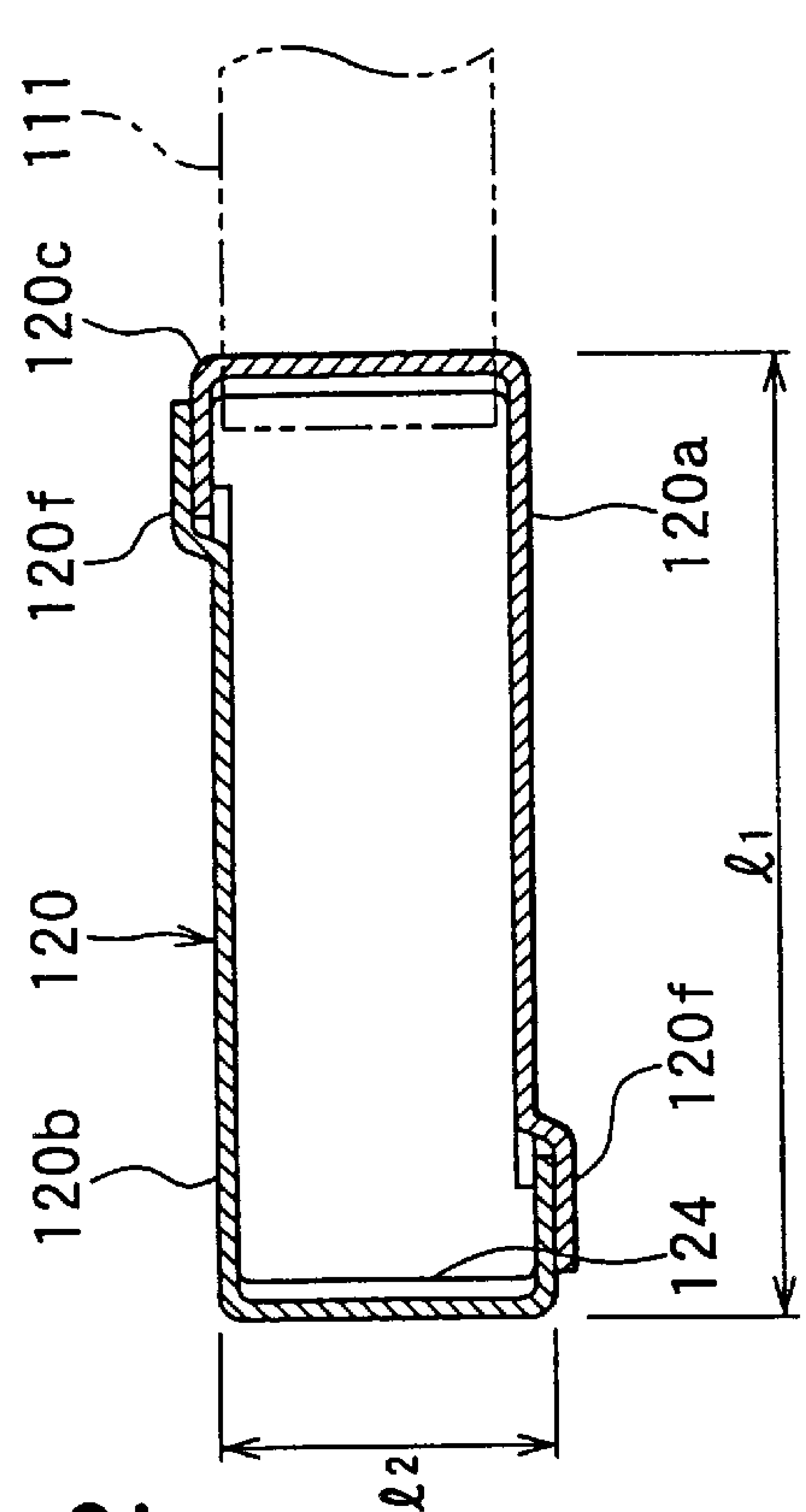


FIG. 2

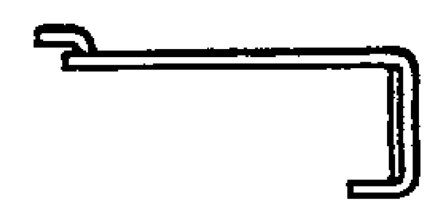


FIG. 3C

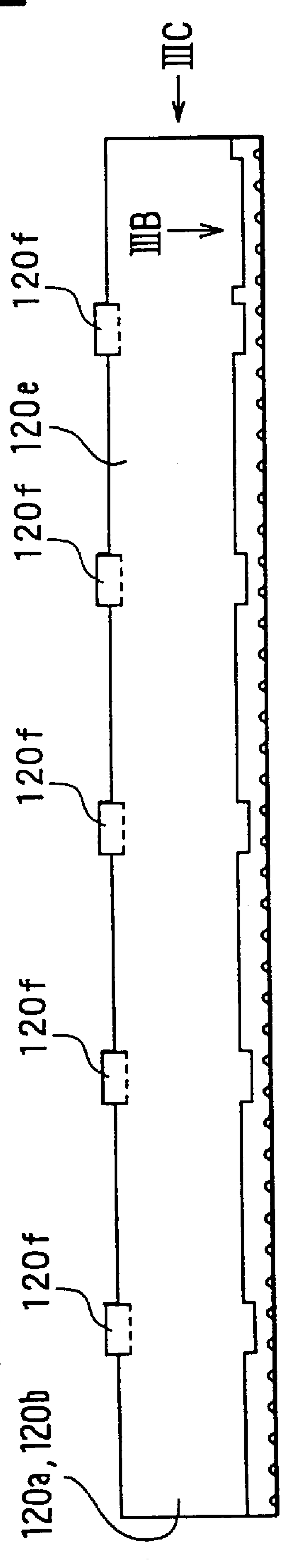


FIG. 3A

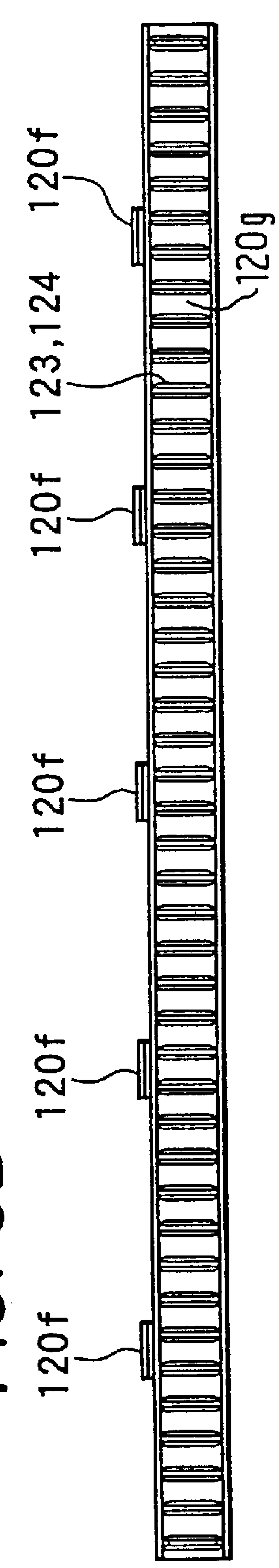


FIG. 3B

FIG. 4

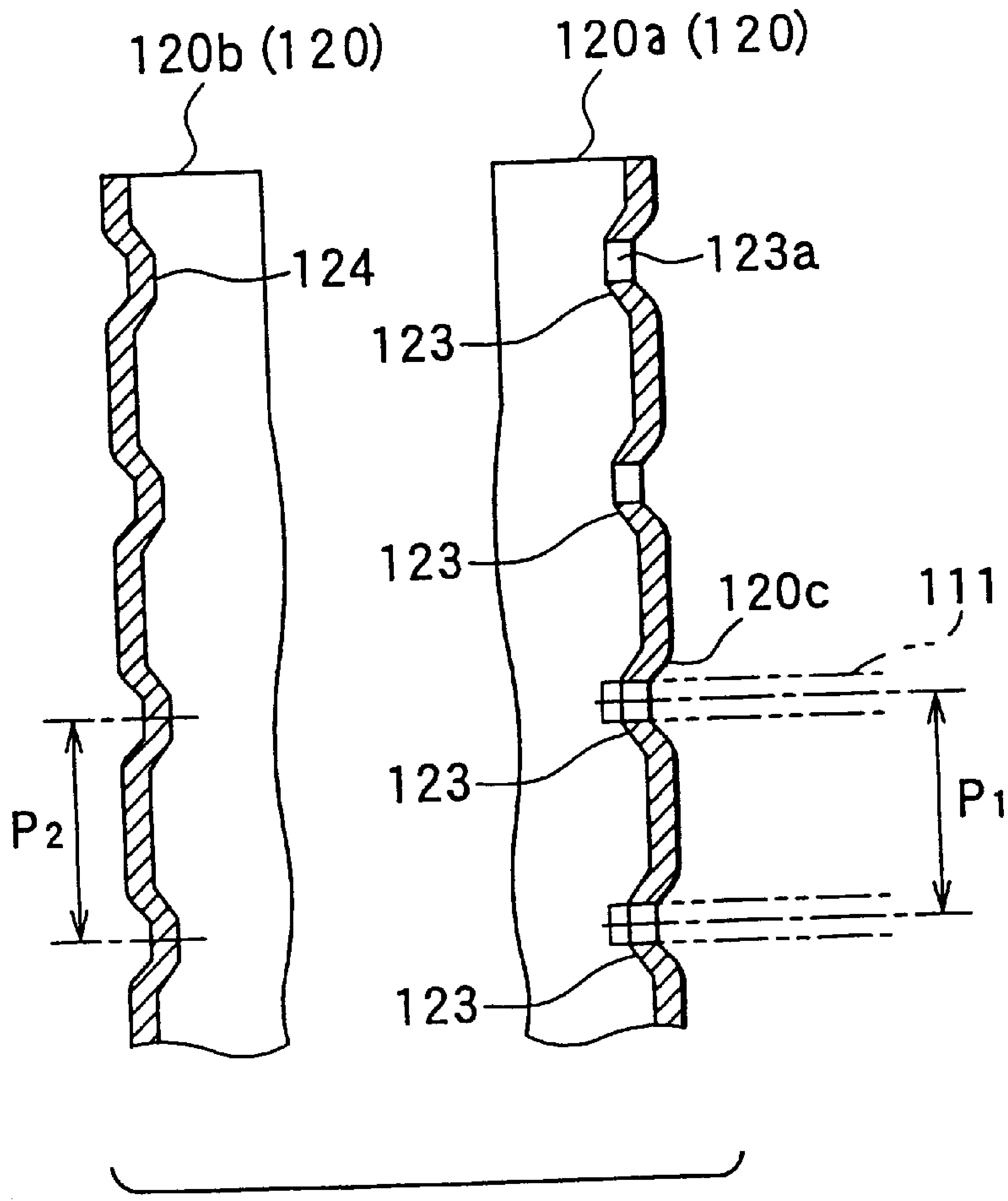

120b (120)
120a (120)
124
123a
123
123
120c
111
123
P2
P1
123

FIG. 5

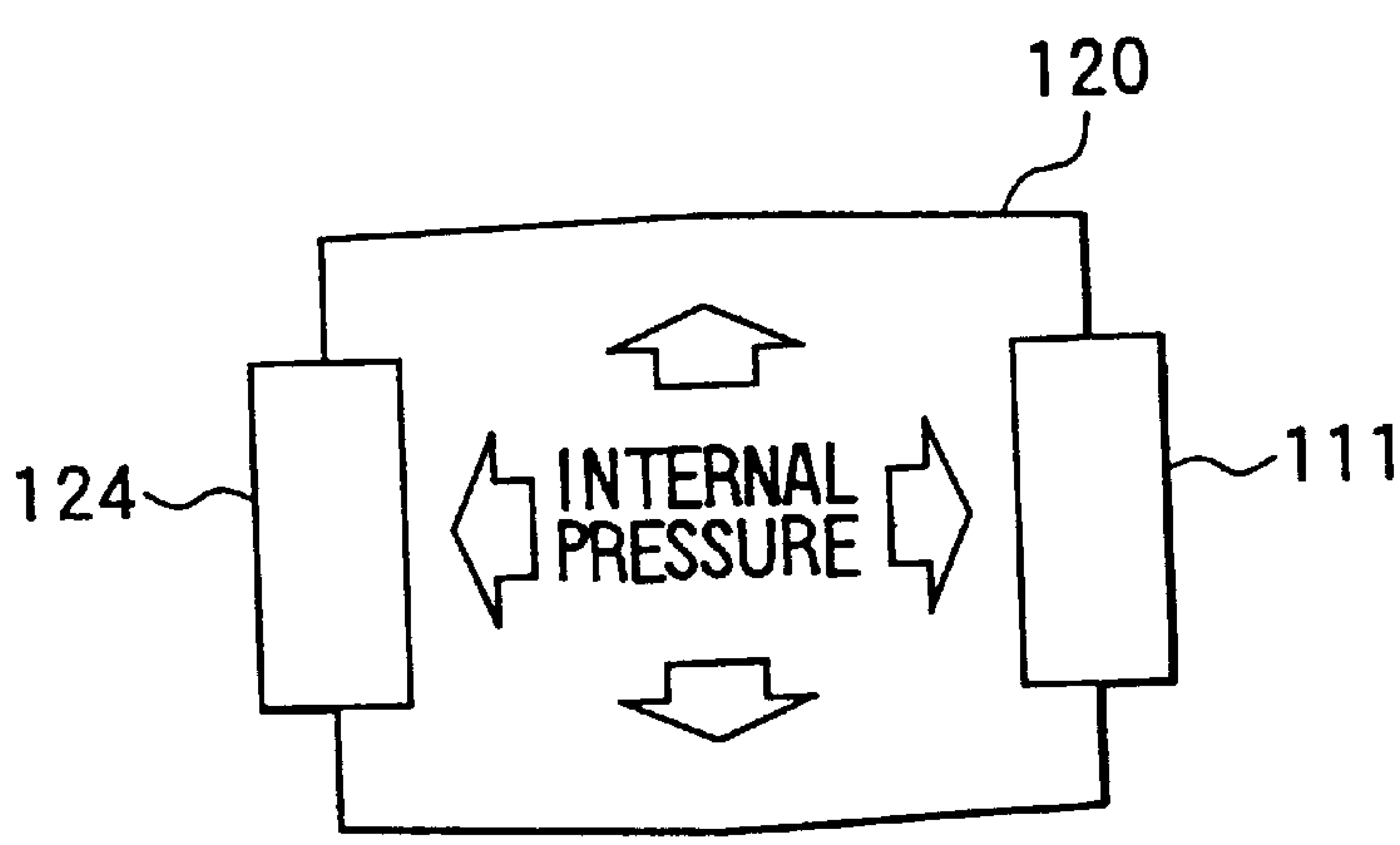

120
124
INTERNAL PRESSURE
111

FIG. 6

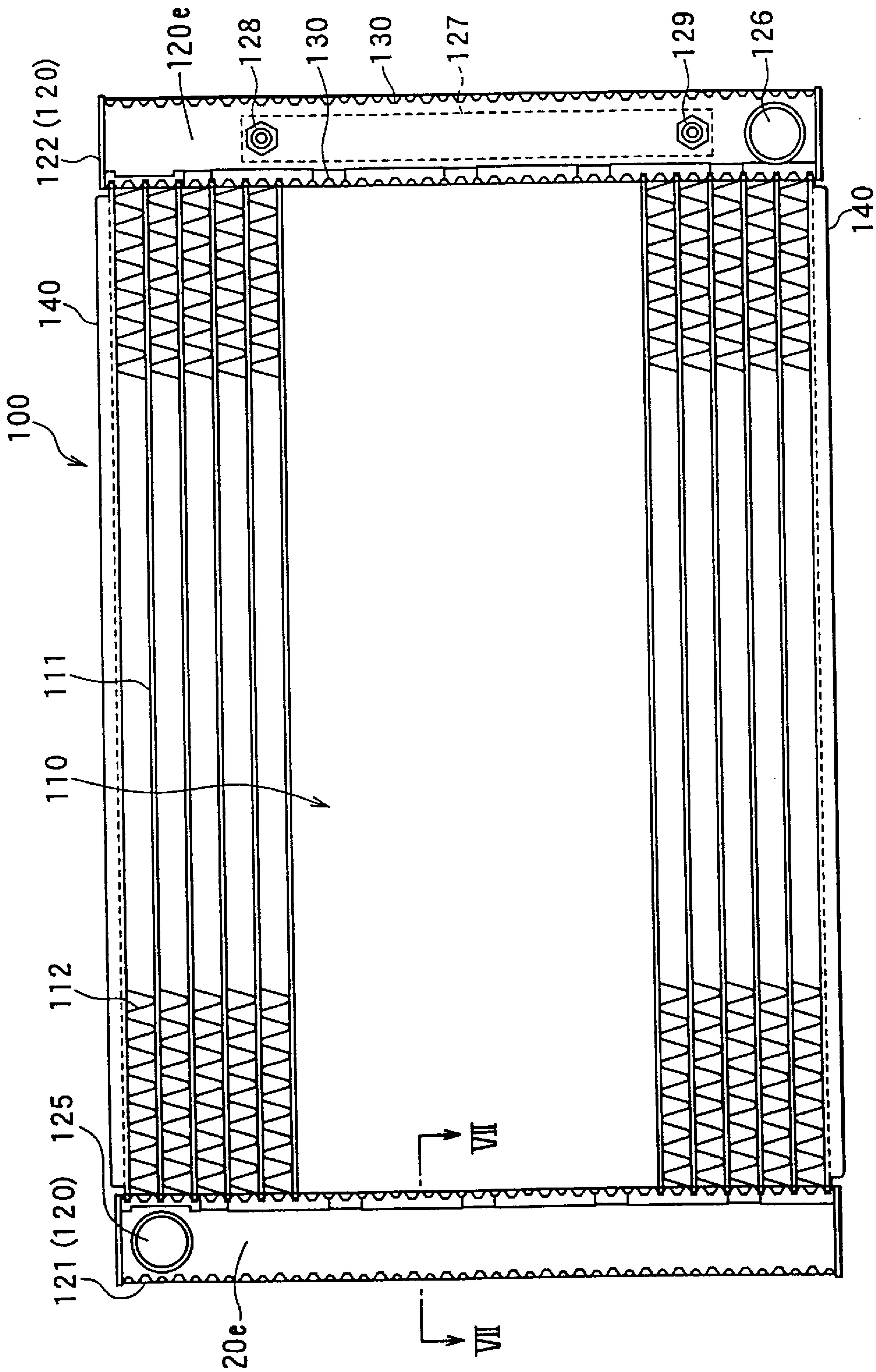

122 (120)
120e
128
130
130
127
129
126
140
140
100
111
110
112
125
121 (120)
120e
VII
VII

FIG. 7

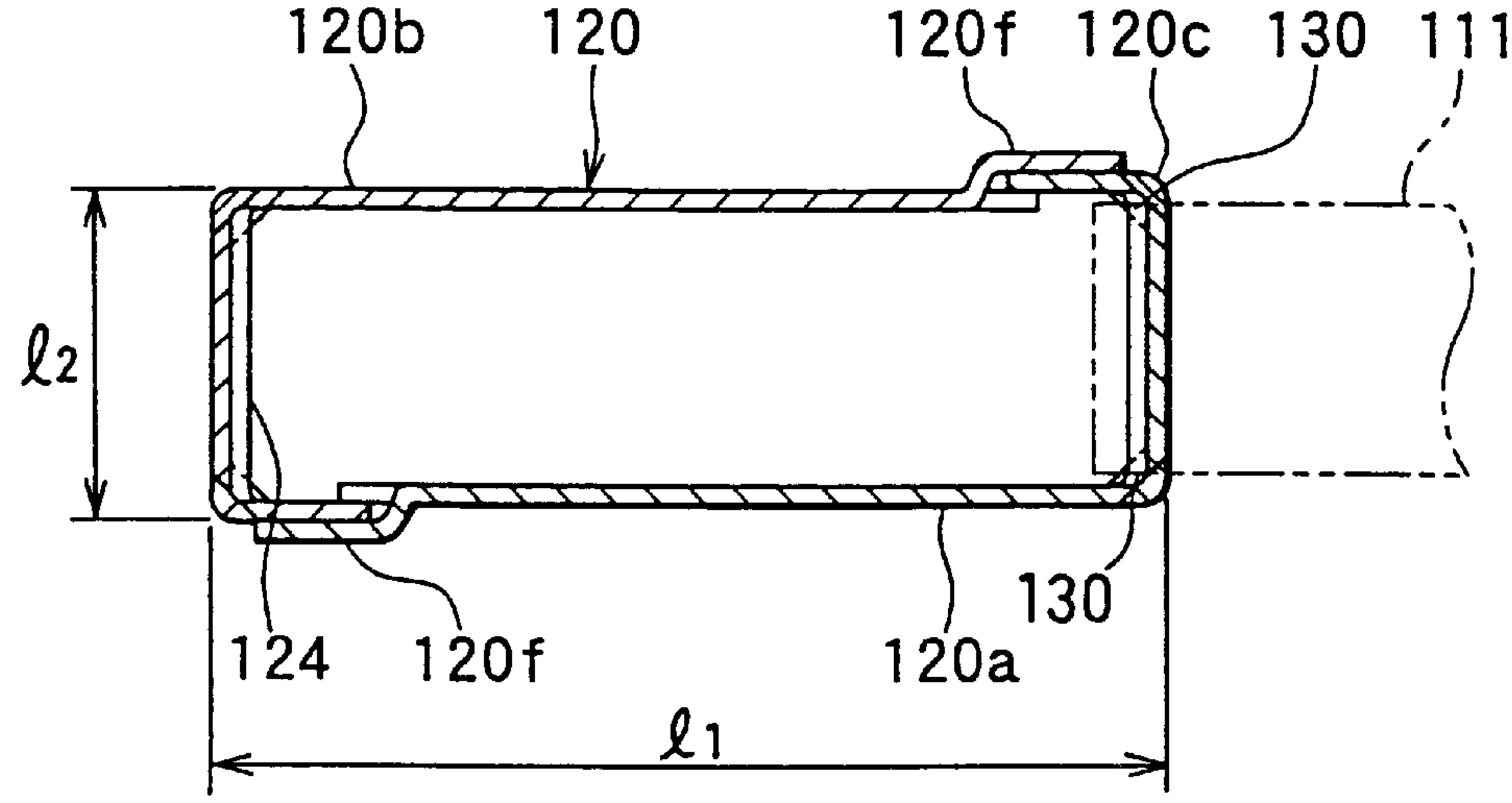


FIG. 8A

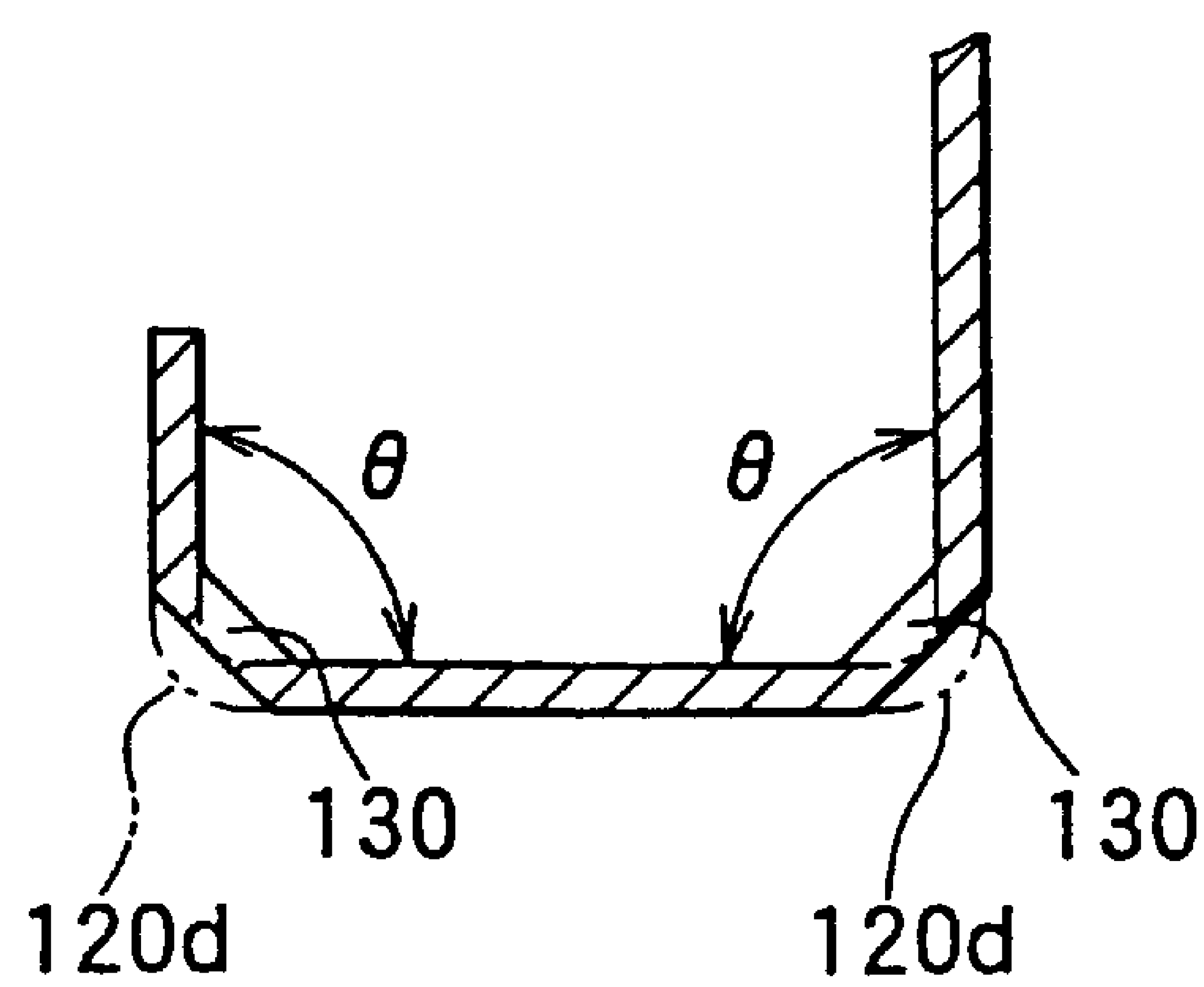


FIG. 8B

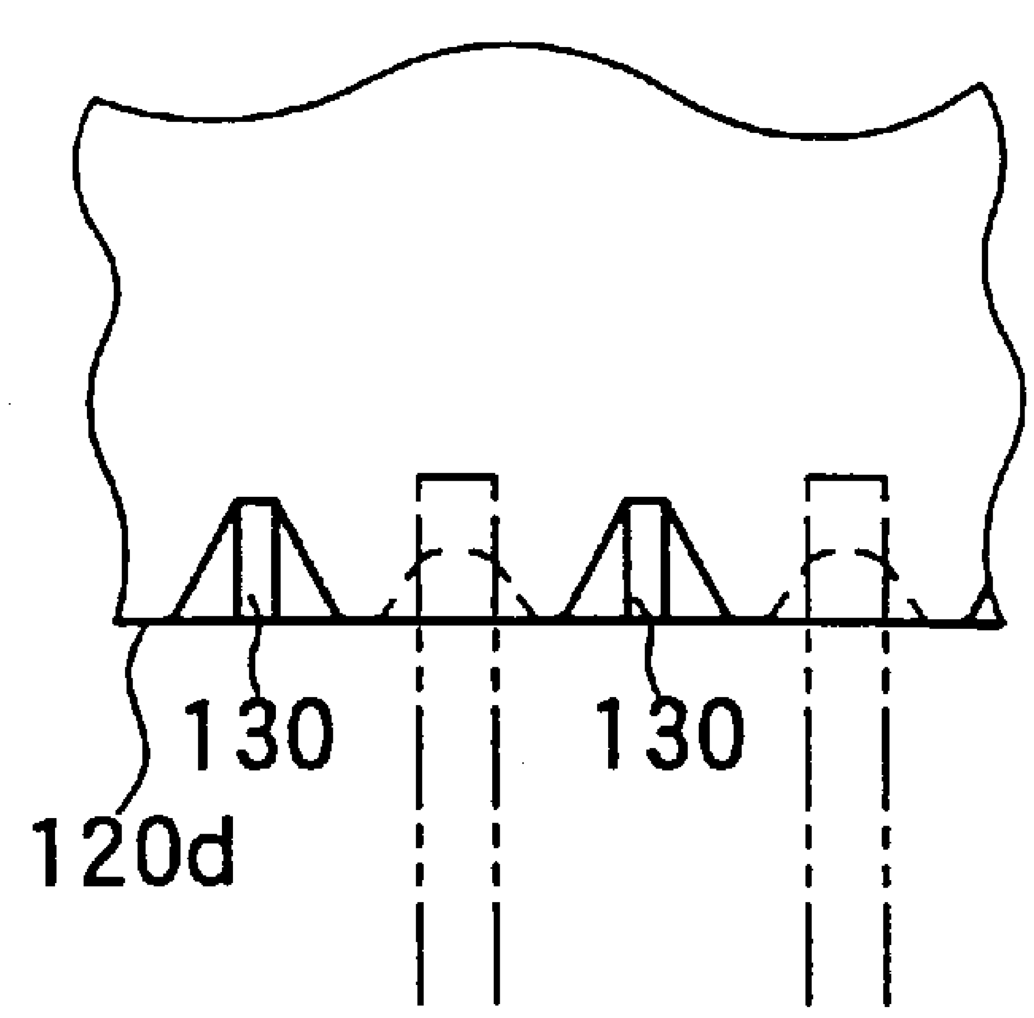
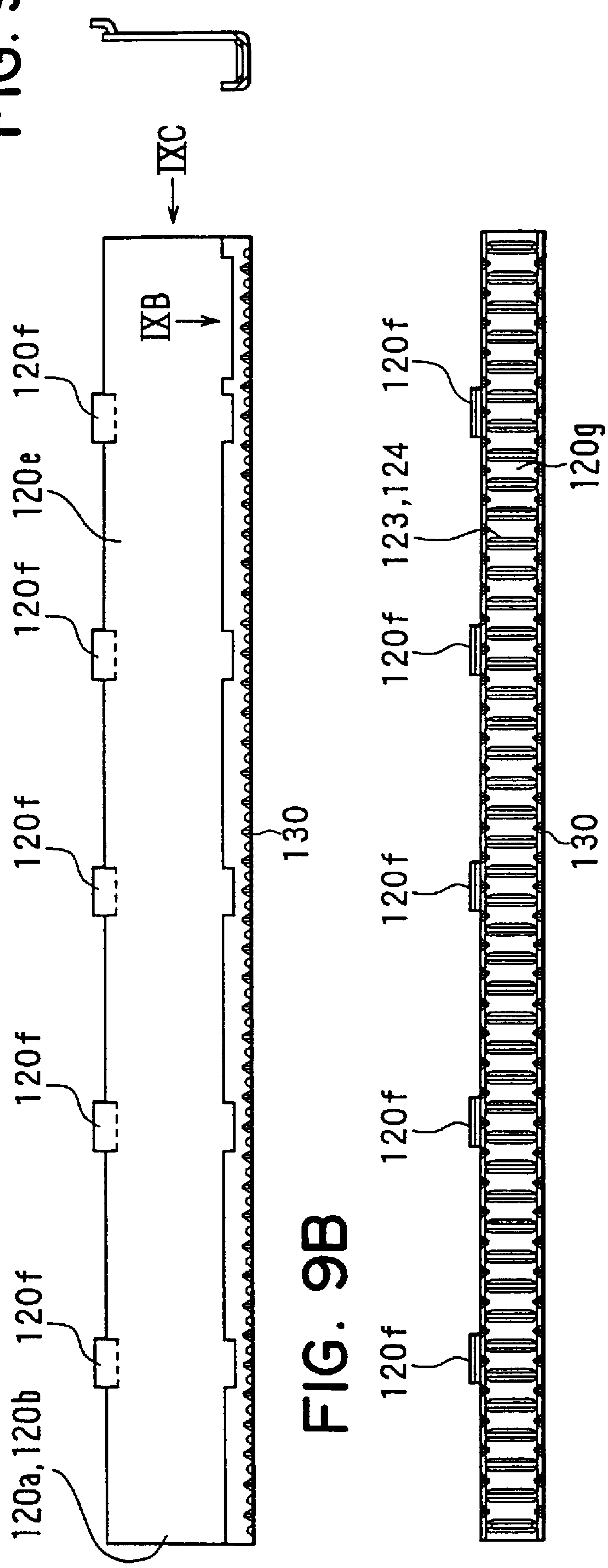


FIG. 9C

FIG. 9A

FIG. 9B



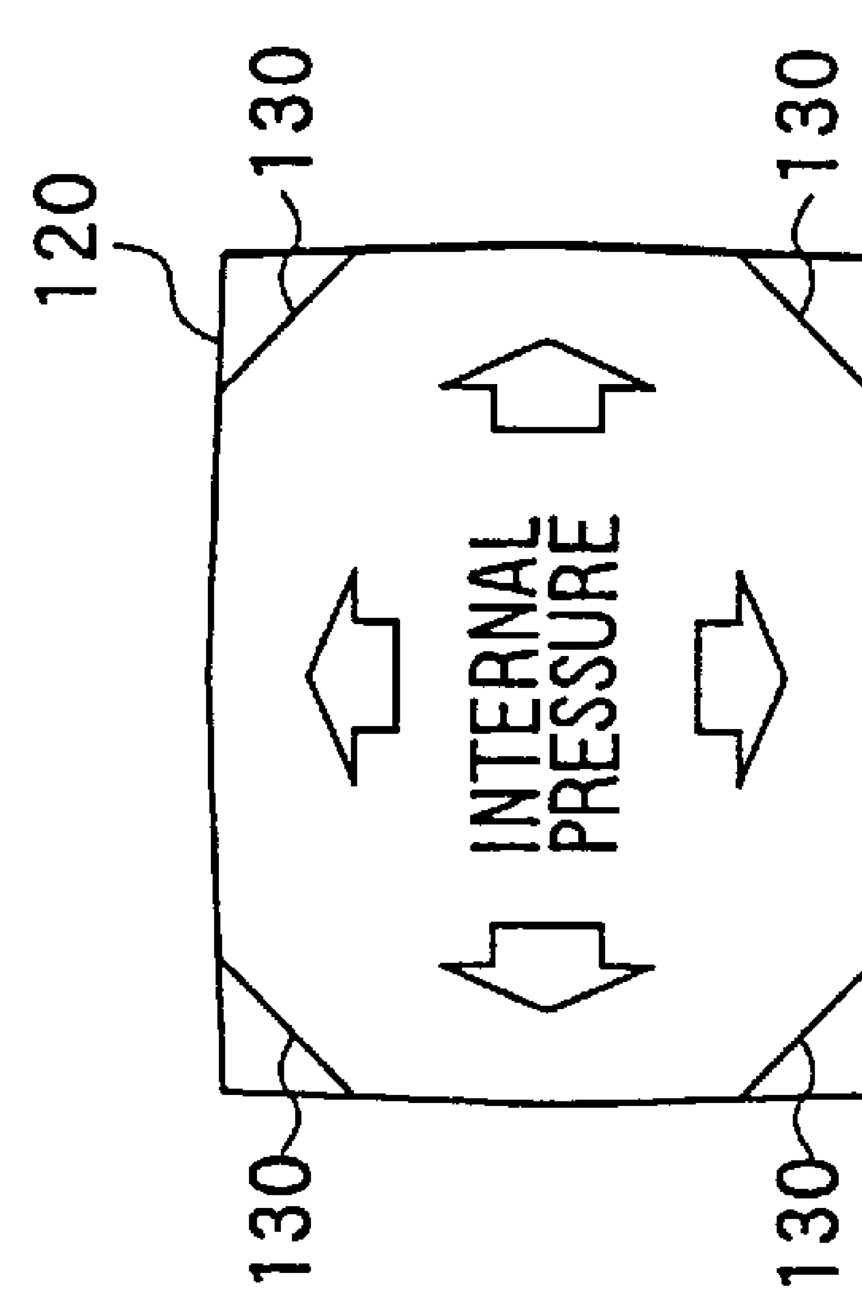
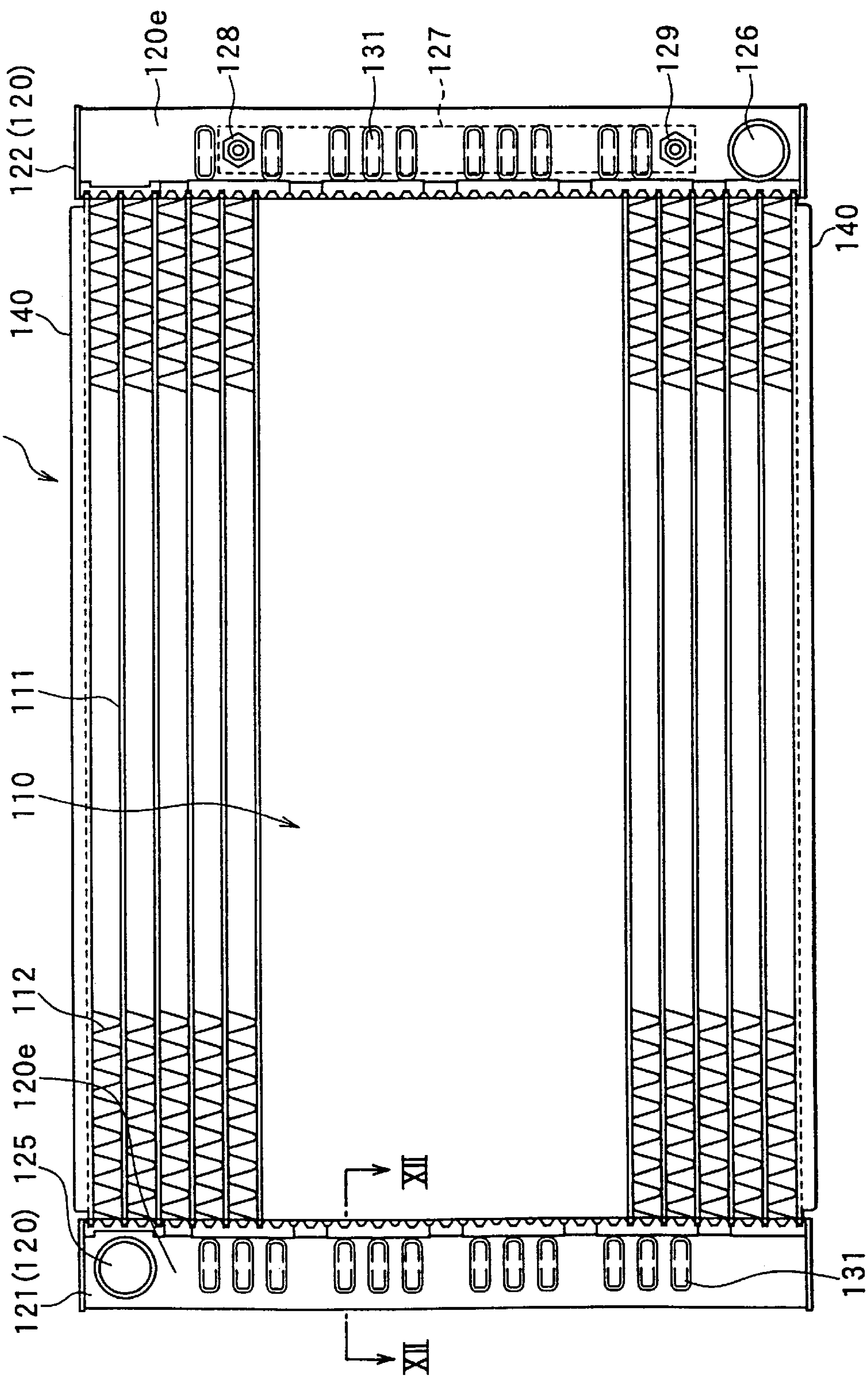


FIG. 10

FIG. 11



122(120)
120e
128
131
127
129
126
140
140
100
111
110
112
120e
125
121(120)
131
XII
XII

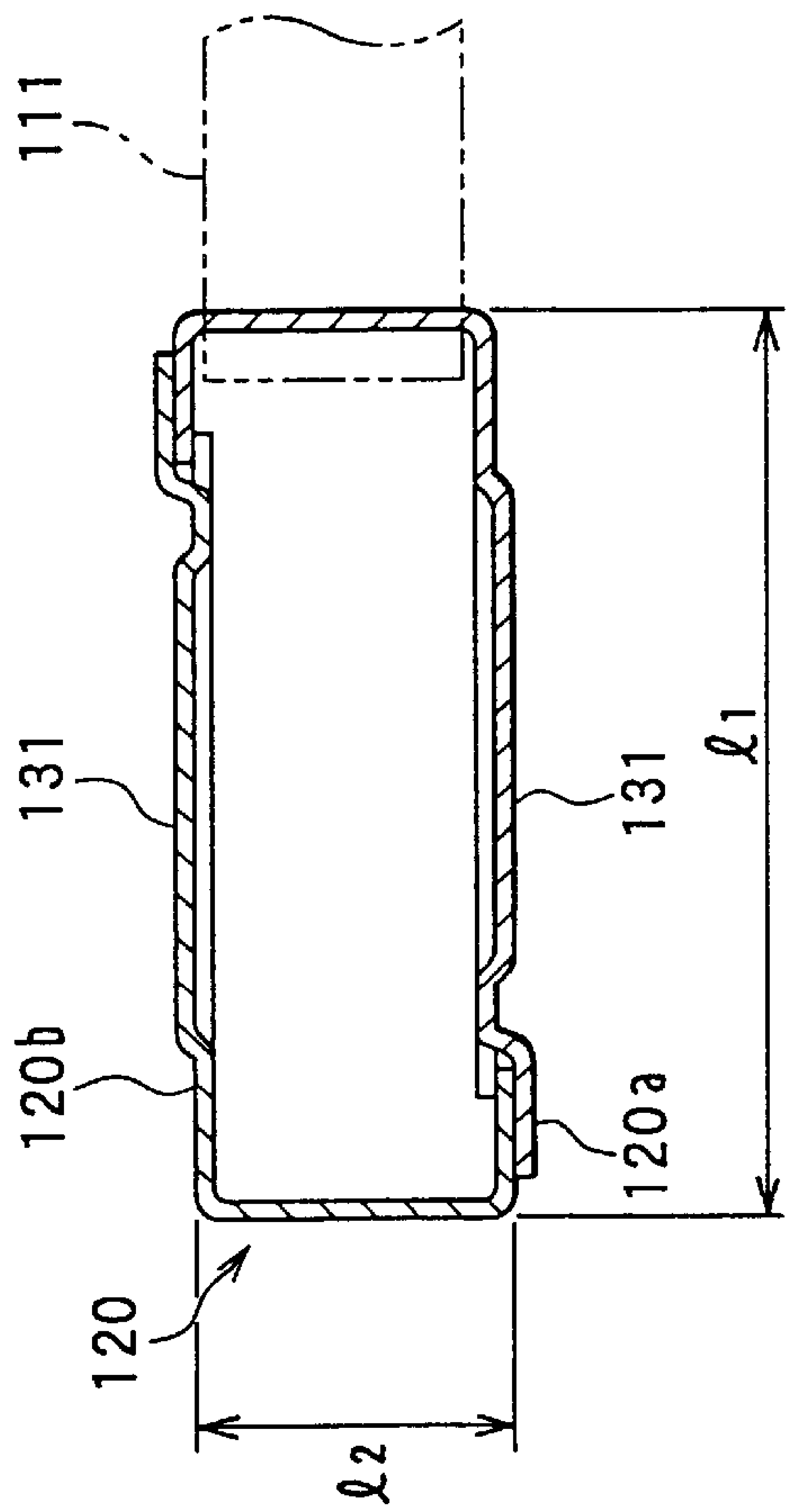


FIG. 12

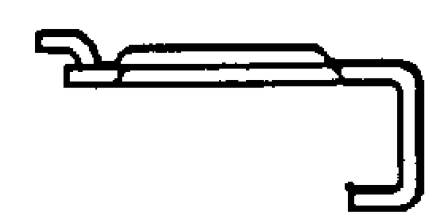


FIG. 13C

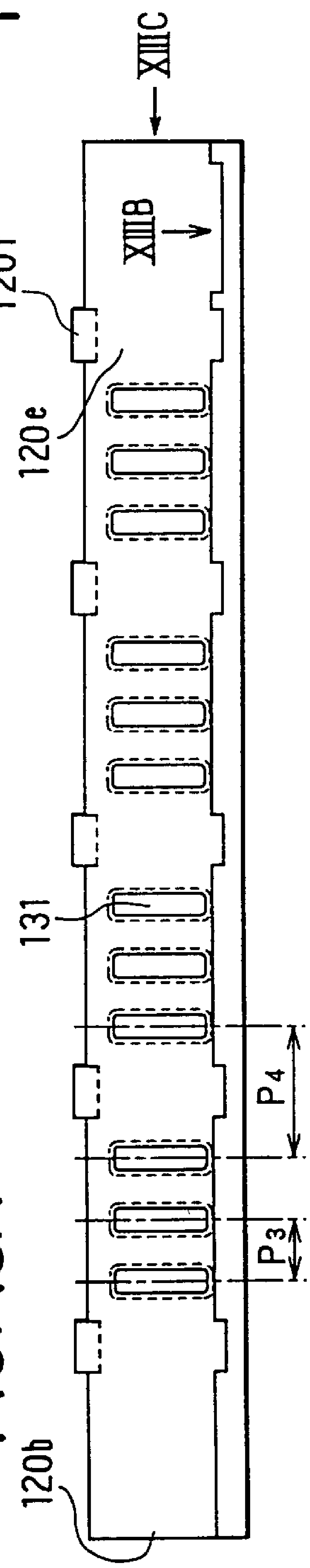


FIG. 13A

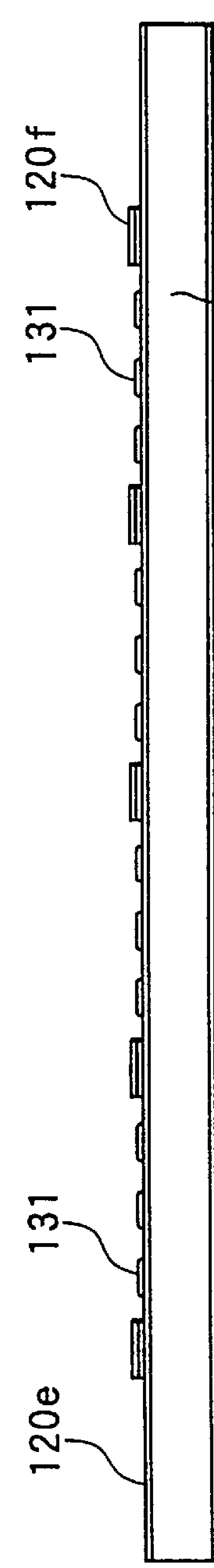
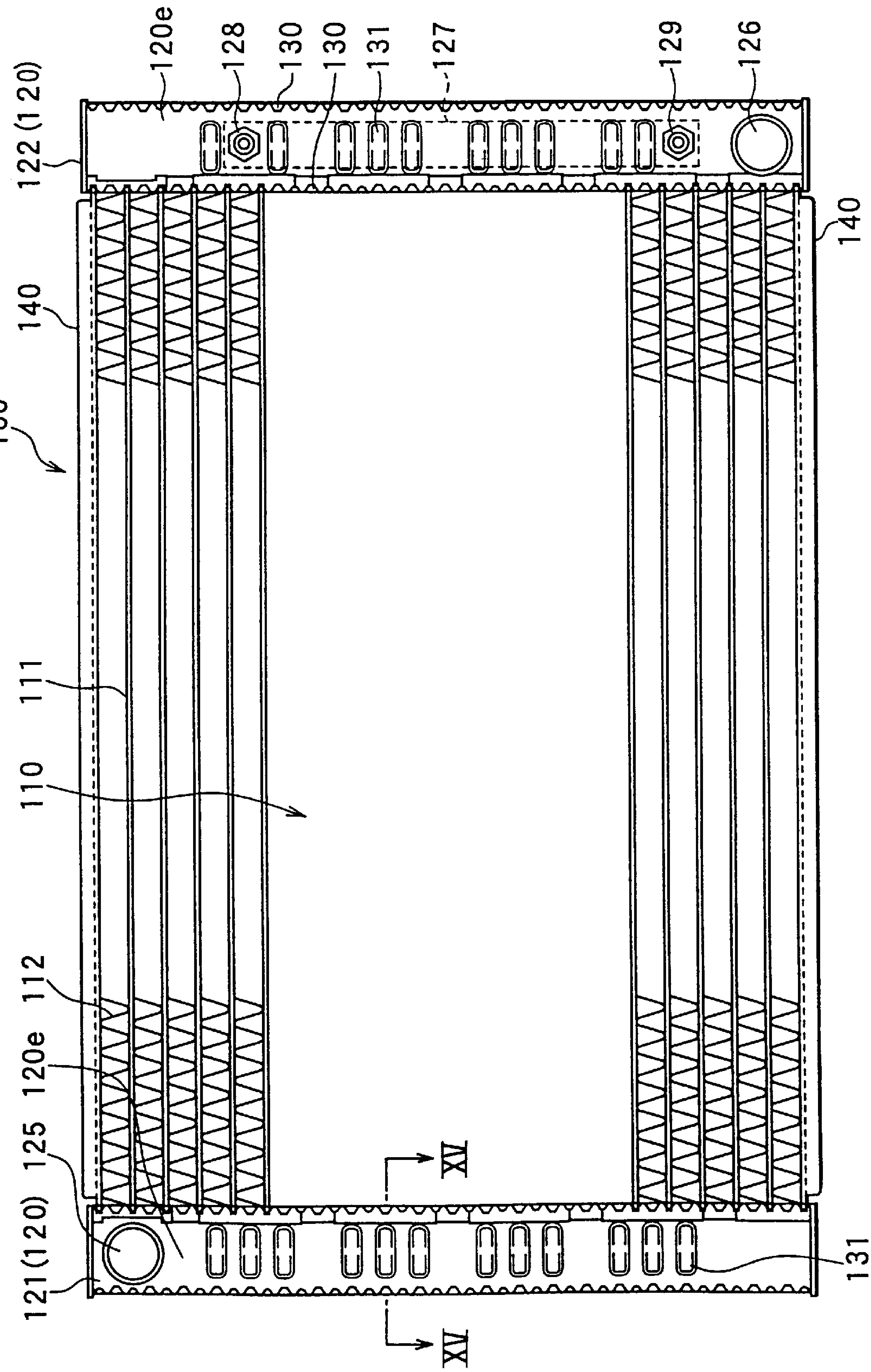


FIG. 13B

FIG. 14



122(120)
120e
128
130
130
131
127
129
126
140
140
100
111
110
112
120e
125
121(120)
XI
XI
131

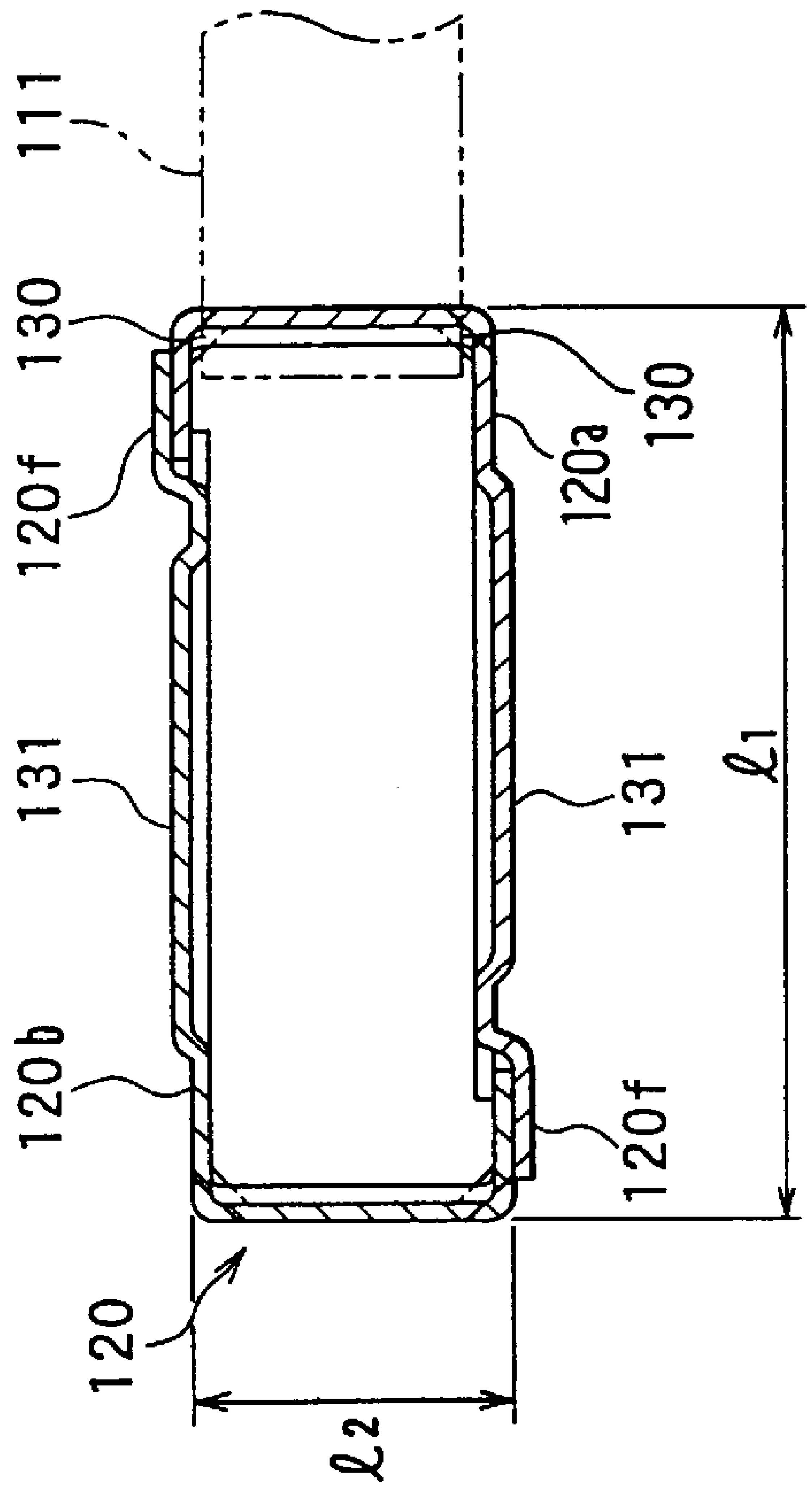


FIG. 15

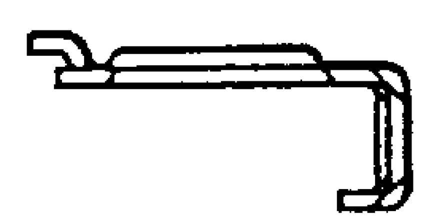


FIG. 16C

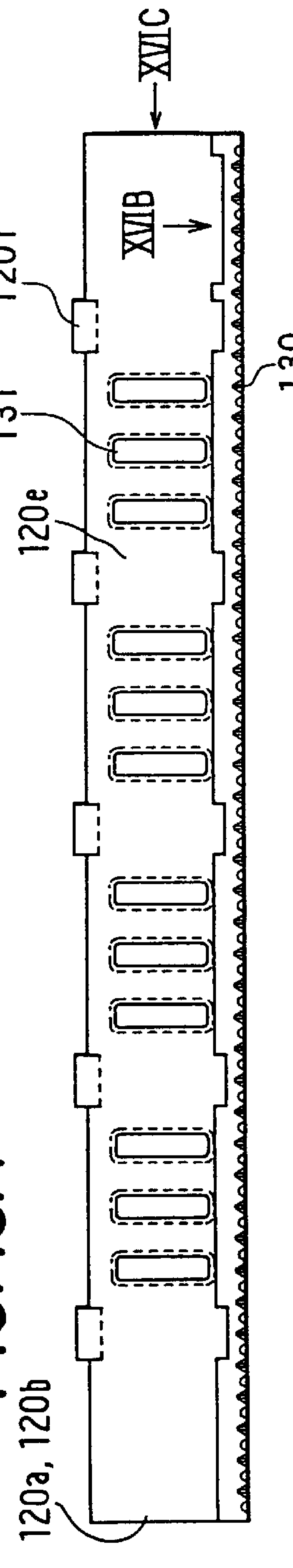


FIG. 16A

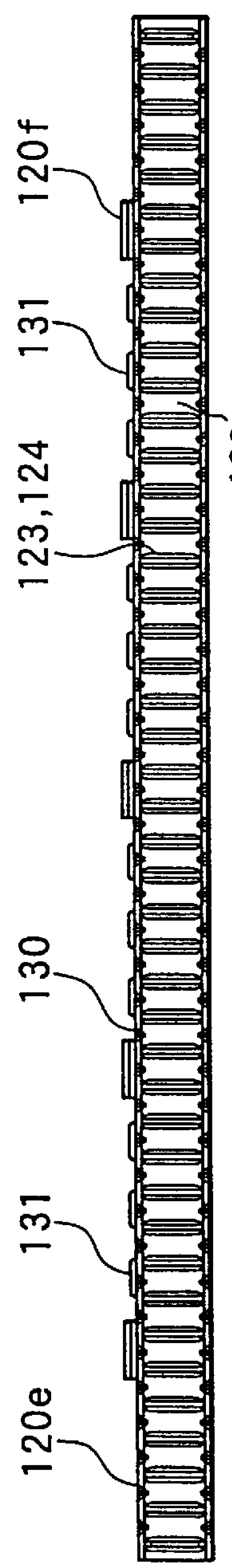


FIG. 16B

FIG. 17

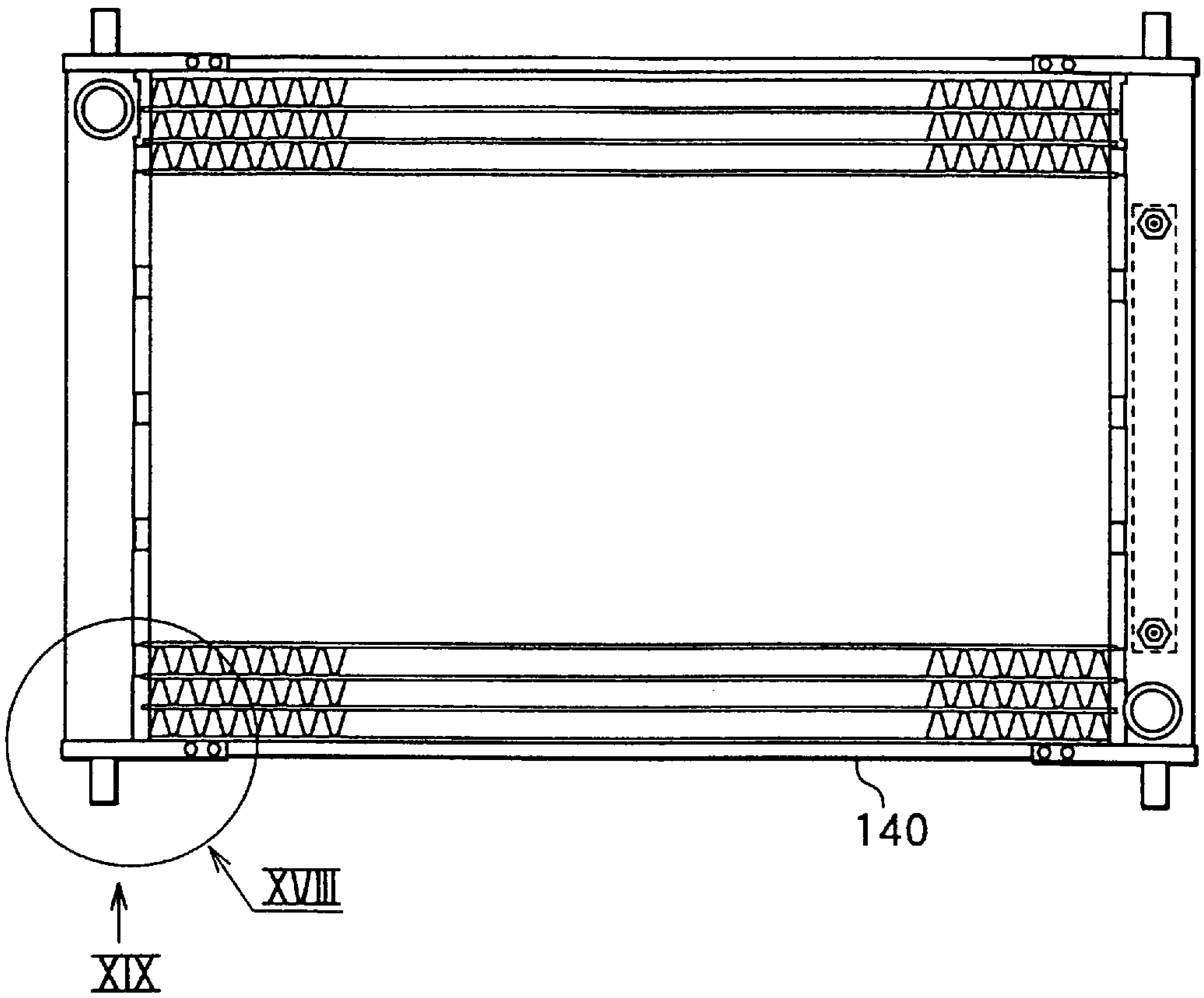


FIG. 18

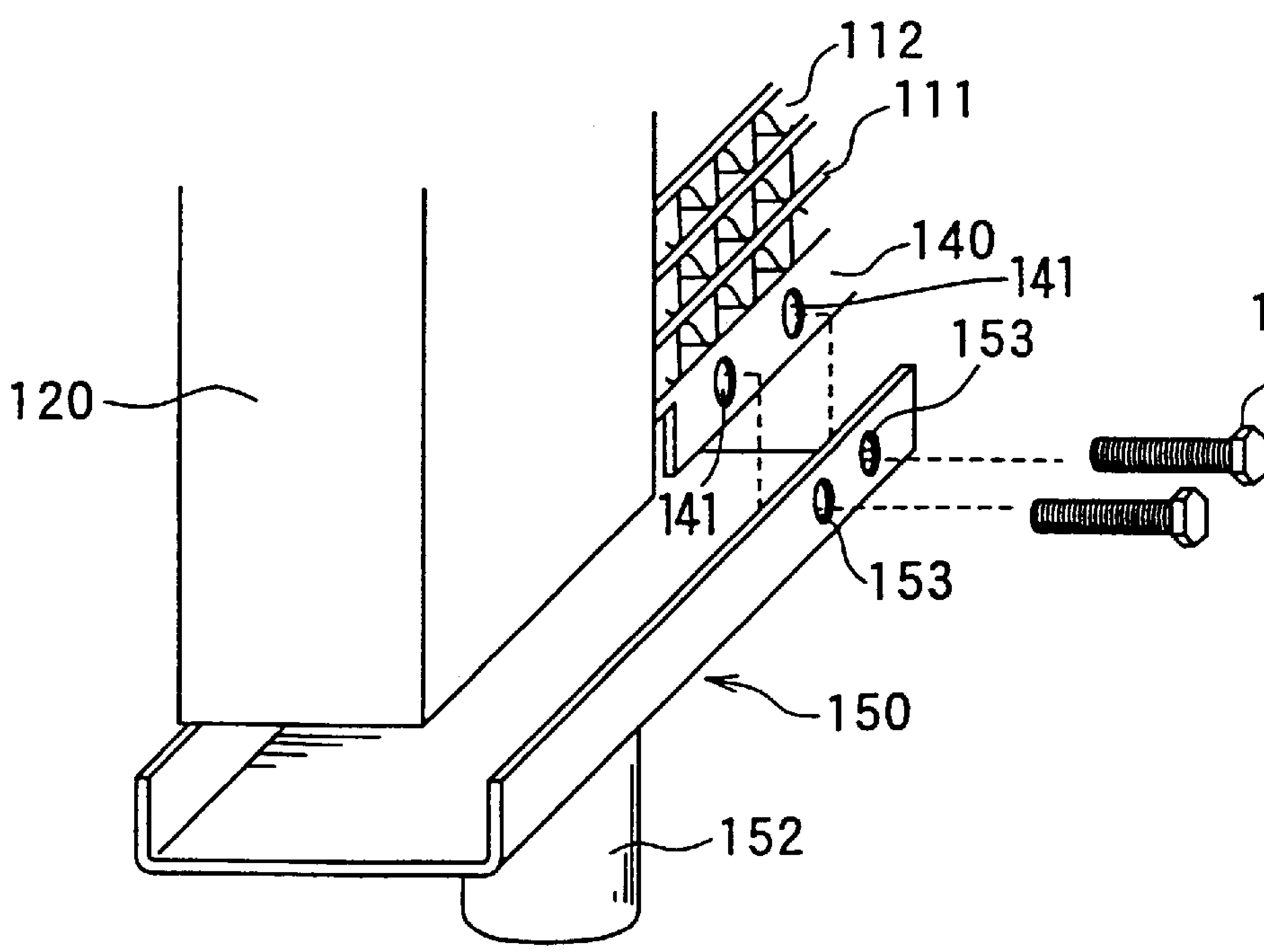


FIG. 19

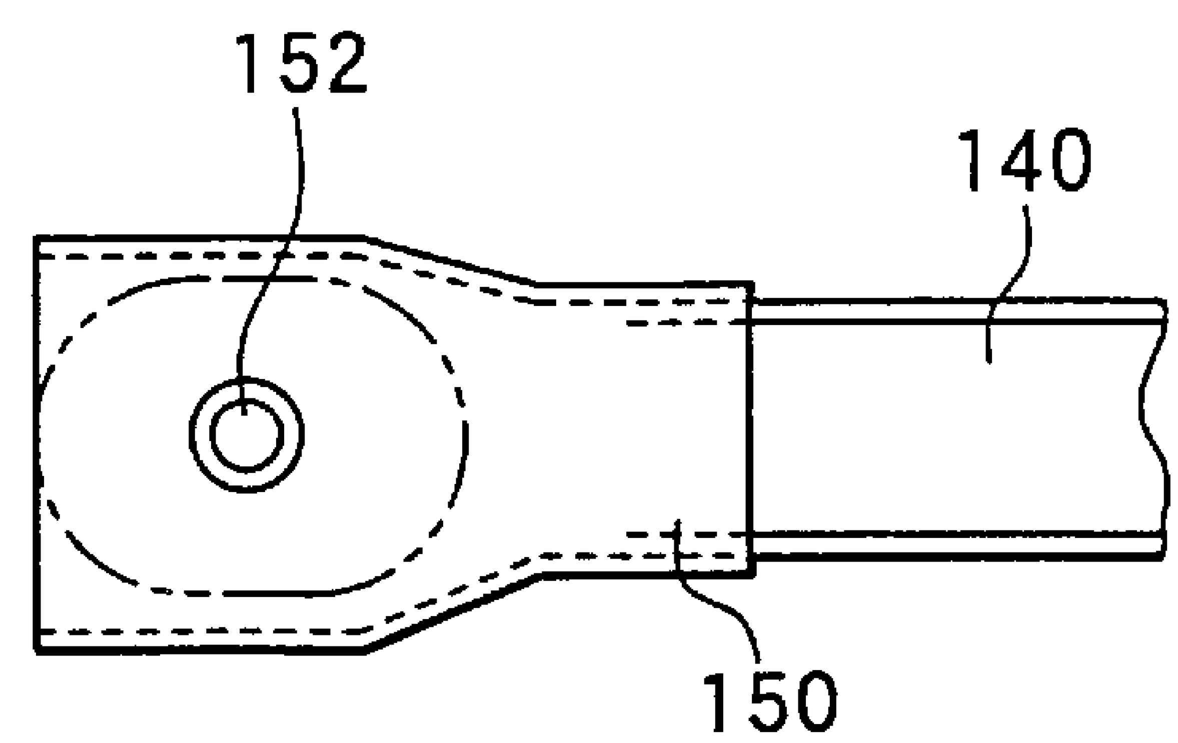


FIG. 20

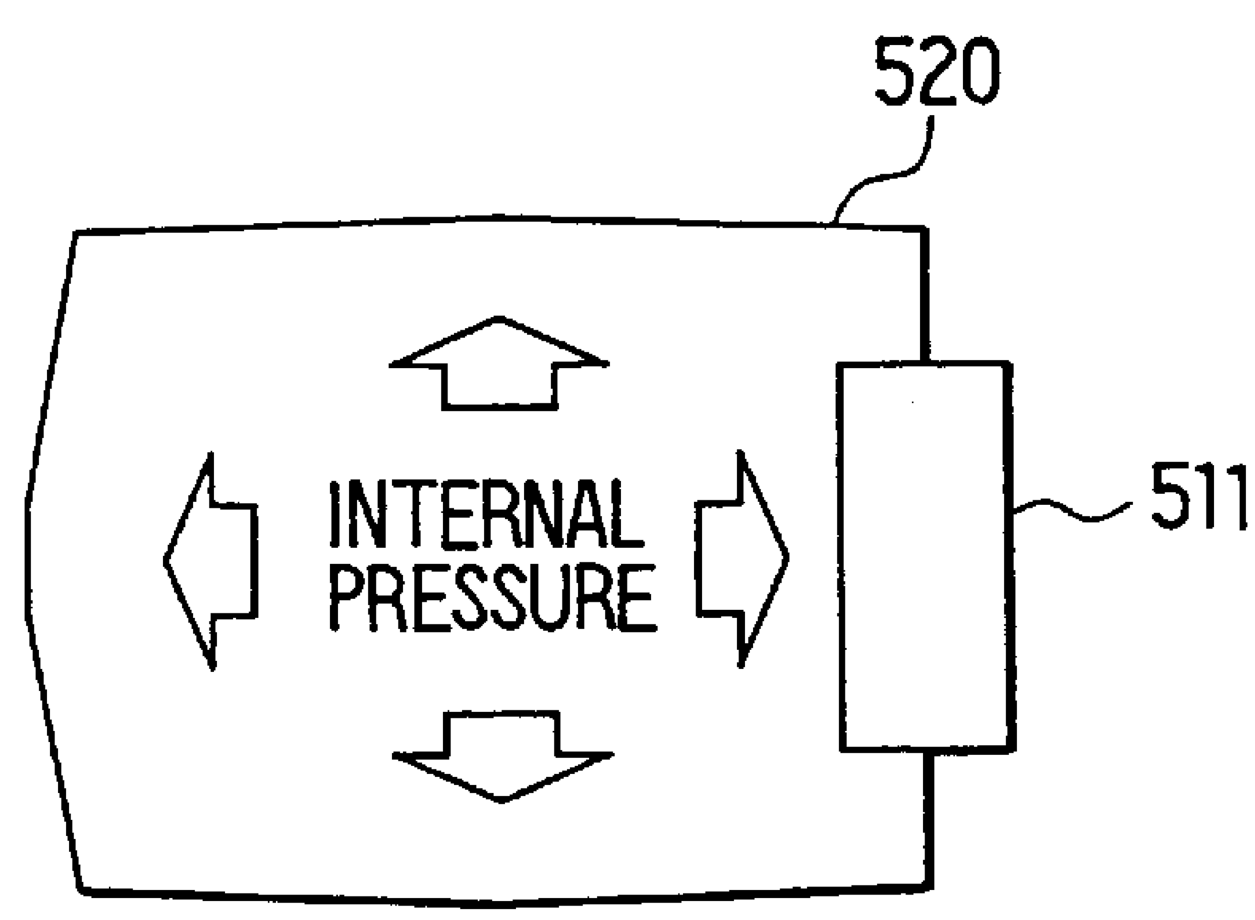
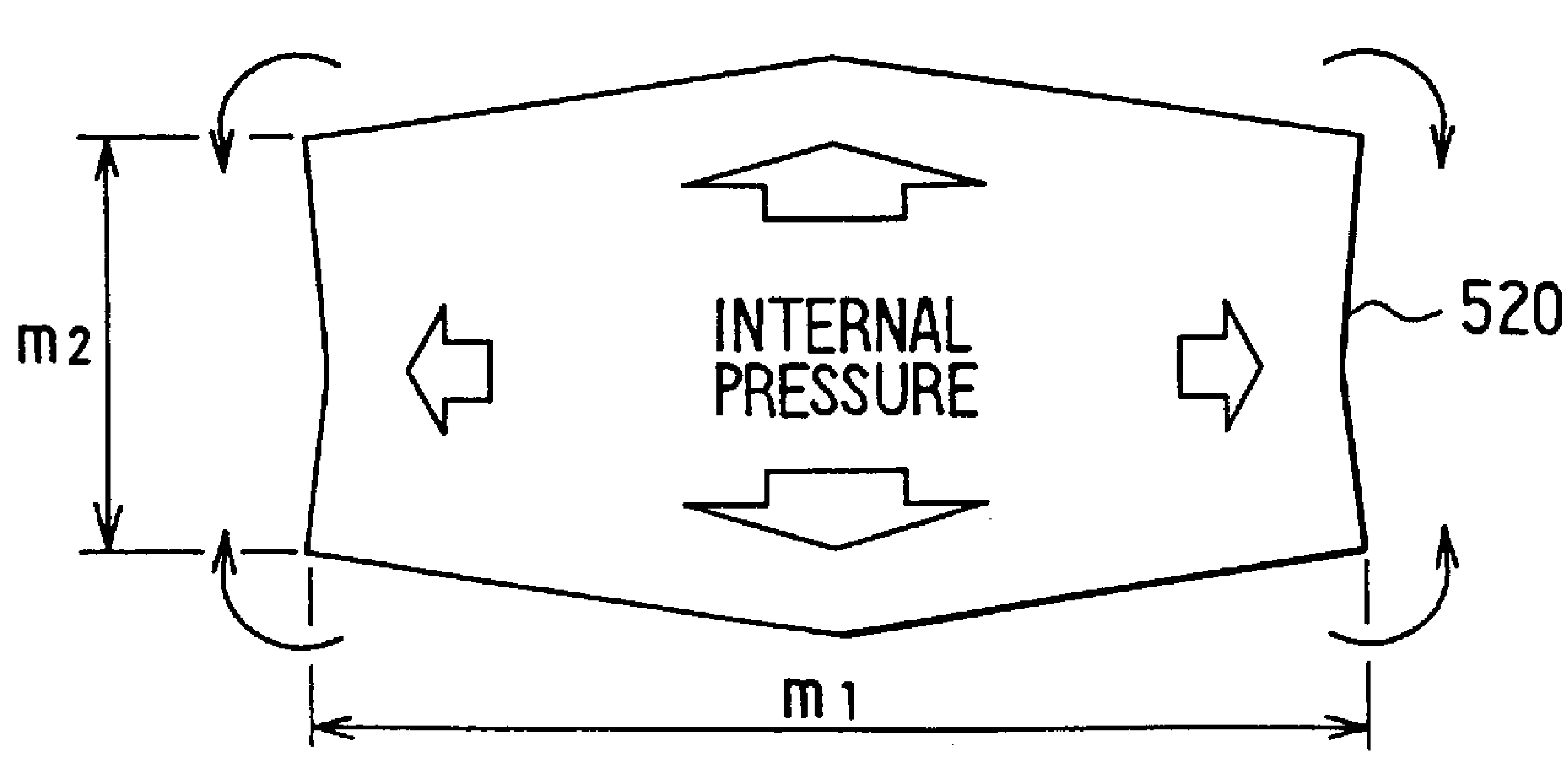


FIG. 21



HEAT EXCHANGER HAVING HEADER TANK

CROSS REFERENCE TO RELATED APPLICATIONS

This application relates to and claims priority from Japanese Patent Application No. 11-89794 filed on Mar. 30, 1999, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to heat exchangers, and is suitably applied to a radiator which radiates heat of coolant of a water-cooled engine of a vehicle into atmospheric air.

2. Related Art

JP-U-58-154389 discloses a radiator having plural metal tubes and a header tank communicating with the tubes. The header tank is formed by connecting a metal core plate and a resin tank body by clamping. The tubes are brazed to the core plate. Recently, recycling performance of vehicle parts such as a radiator is demanded to be improved for reducing industrial waste. However, since the above-mentioned radiator is made of at least two kinds of materials including metal and resin, parts of the radiator needs to be divided into metal parts and resin parts for recycling. Therefore, the number of processes for recycling the radiator is increased, and recycling performance of the radiator is low.

SUMMARY OF THE INVENTION

As shown in FIG. **20**, when a header tank **520** of a radiator (not shown) is made of only metal with a relatively small rigidity or a relatively small Young's modulus such as aluminum, the header tank **520** may not have a sufficient mechanical strength. As a result, the header tank **520** may be readily deformed by an internal pressure thereof to be expanded. Further, a connection portion of the header tank **520** to which a tube **511** is connected has a mechanical strength larger than that of a non-connection portion of the header tank **520** to which no tube **511** is connected. As a result, the non-connection portion of the header tank **520** may be intensively applied with stress and largely deformed.

Furthermore, as shown in FIG. **21**, when the header tank **520** has a rectangular cross-section having a longer side ml and a shorter side m**2**, a longer-side wall of the header tank **520** has a larger area than a shorter-side wall of the header tank **520**. Therefore, the longer-side wall is applied with a larger amount of the internal pressure of the header tank **520** than the shorter-side wall and may be largely deformed. Deformation of the header tank **520** may be restricted by increasing a thickness of a metal plate from which the header tank **520** is formed. However, in this case, a weight and a manufacturing cost of the radiator may be increased.

In view of the foregoing problems, it is an object of the present invention to provide a heat exchanger including a metal header tank having a sufficient mechanical strength without increasing a weight and a manufacturing cost of the heat exchanger.

According to the present invention, a heat exchanger has a plurality of metal tubes through which fluid flows, and a metal header tank disposed at a flow-path end of the tubes to extend in a direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes. The header tank includes first and second walls opposite each other. The first wall has a plurality of connection portions each of which is connected to each of the tubes. The second wall has a plurality of first reinforcement ribs which increase a rigidity of the header tank. The connection portions are arranged in the direction perpendicular to the longitudinal direction of the tubes at a first pitch. The first reinforcement ribs are arranged in the direction perpendicular to the longitudinal direction of the tubes at a second pitch approximately equal to the first pitch.

Therefore, a rigidity of a non-connection portion of the header tank to which no tube is connected is increased by the first reinforcement ribs, and stress is restricted from being intensively applied to the non-connection portion. As a result, a mechanical strength of the header tank is increased without increasing a thickness of a metal plate from which the header tank is formed, thereby restricting a weight and a manufacturing cost of the heat exchanger from increasing.

Preferably, the header tank is formed by connecting a first tank member and a second tank member each of which is formed by pressing to have a L-shaped cross-section so that the first and second tank members are formed using the same die.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of the present invention will become more readily apparent from a better understanding of the preferred embodiments described below with reference to the accompanying drawings, in which:

FIG. **1** is a schematic front view showing a radiator according to a first preferred embodiment of the present invention;

FIG. **2** is a sectional view taken along line II—II in FIG. **1**;

FIG. **3**A is a front view showing first and second tank members of a header tank of the radiator according to the first embodiment;

FIG. **3**B is a bottom view taken from arrow IIIB in FIG. **3**A;

FIG. **3**C is a side view taken from arrow IIIC in FIG. **3**A;

FIG. **4** is an enlarged sectional view showing the header tank according to the first embodiment;

FIG. **5** is a schematic view showing an internal pressure of the header tank according to the first embodiment;

FIG. **6** is a schematic front view showing a radiator according to a second preferred embodiment of the present invention;

FIG. **7** is a sectional view taken along line VII—VII in FIG. **6**;

FIG. **8**A is a partial sectional view showing a header tank of the radiator according to the second embodiment;

FIG. **8**B is a partial side view showing the header tank according to the second embodiment;

FIG. **9**A is a front view showing first and second tank members of the header tank according to the second embodiment;

FIG. **9**B is a bottom view taken from arrow IXB in FIG. **9**A;

FIG. **9**C is a side view taken from arrow IXC in FIG. **9**A;

FIG. **10** is a schematic view showing an internal pressure of the header tank according to the second embodiment;

FIG. **11** is a schematic front view showing a radiator according to a third preferred embodiment of the present invention;

FIG. **12** is a sectional view taken along line XII—XII in FIG. **11**;

FIG. **13**A is a front view showing a second tank member of a header tank of the radiator according to the third embodiment;

FIG. **13**B is a bottom view taken from arrow XIIIB in FIG. **13**A;

FIG. **13**C is a side view taken from arrow XIIIC in FIG. **13**A;

FIG. **14** is a schematic front view showing a radiator according to a fourth preferred embodiment of the present invention;

FIG. **15** is a sectional view taken along line XV—XV in FIG. **14**;

FIG. **16**A is a front view showing first and second tank members of a header tank of the radiator according to the fourth embodiment;

FIG. **16**B is a bottom view taken from arrow XVIB in FIG. **16**A;

FIG. **16**C is a side view taken from arrow XVIC in FIG. **16**A;

FIG. **17** is a schematic front view showing a radiator according to a fifth preferred embodiment of the present invention;

FIG. **18** is an enlarged perspective view showing a portion indicated by arrow XVIII in FIG. **17**;

FIG. **19** is a bottom view taken from arrow XIX in FIG. **17**;

FIG. **20** is a schematic view showing deformation of a metal header tank of a radiator by an internal pressure thereof; and

FIG. **21** is a schematic view showing deformation of a metal header tank having a rectangular cross-section of a radiator by an internal pressure thereof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention are described hereinafter with reference to the accompanying drawings.

(First Embodiment)

A first preferred embodiment of the present invention will be described with reference to FIGS. **1**–**5**. In the first embodiment, the present invention is applied to a radiator **100** for a vehicle. In FIG. **1**, the radiator **100** is viewed from an upstream air side with respect to air passing through the radiator **100**. As shown in FIG. **1**, the radiator **100** has plural flat tubes **111** through which coolant from an engine (not shown) of the vehicle flows. Each of the tubes **111** is formed from aluminum by extrusion or drawing. Plural aluminum corrugated fins **112** formed by a roller are disposed between adjacent tubes **111** for facilitating heat-exchange between coolant and air passing through the radiator **100**. The tubes **111** and the fins **112** form a core portion **110** of the radiator **100** which cools coolant by heat-exchange between coolant and air.

The radiator **100** also includes first and second aluminum header tanks **121**, **122** respectively disposed at one flow-path end (i.e., left end in FIG. **1**) of the tubes **111** and the other flow-path end (i.e., right end in FIG. **1**) of the tubes **111**. Each of the first and second header tanks **121**, **122** extends in a direction perpendicular to a longitudinal direction of the tubes **111** and communicates with the tubes **111**. Coolant is introduced into the first header tank **121** through an inlet pipe **125**, and is distributed into each of the tubes **111**. After being heat-exchanged with air, coolant is collected into the second header tank **122**, and is discharged toward the engine through an outlet pipe **126**. The inlet pipe **125** is connected to a coolant outlet of the engine, and the outlet pipe **126** is connected to a coolant inlet of the engine. Hereinafter, each of the first and second header tanks **121**, **122** is referred to as a header tank **120**.

As shown in FIG. **2**, the header tank **120** has a rectangular cross-section with a longer side **11** and a shorter side **12**. The longer side **11** is disposed to extend in a direction parallel with the longitudinal direction of the tubes **111**, that is, in a direction perpendicular to an air-flow direction in which air passes through the radiator. In the first embodiment, the longer side **11** is set to 40 mm or more, and the shorter side **12** is set to 35 mm or less.

As shown in FIGS. **2**–**3**C, the header tank **120** is formed by connecting first and second tank members **120***a*, **120***b* by brazing. Each of the first and second tank members **120***a*, **120***b* is formed to have a L-shaped cross-section by pressing. As shown in FIGS. **3**A–**3**C, each of the first and second tank members **120***a*, **120***b* has a longer-side wall **120***e* and a shorter-side wall **120***g*. The first and second tank members **120***a*, **120***b* respectively have plural first and second protruding portions **123**, **124** formed on the shorter-side walls **120***g* thereof. The first and second protruding portions **123**, **124** are formed to protrude inside the header tank **120** by pressing.

As shown in FIG. **4**, the first protruding portions **123** are arranged in the direction perpendicular to the longitudinal direction of the tubes **111** along the first tank member **120***a* at a pitch P1. The second protruding portions **124** are also arranged in the direction perpendicular to the longitudinal direction of the tubes **111** along the second tank member **120***b* at a pitch P2. The first tank member **120***a* has plural through holes **123***a* each of which is bored through a protruding end of each of the first protruding portions **123**. Each of the tubes **111** is inserted into each of the through holes **123***a* and is connected to the header tank **120**, thereby providing a connection portion **120***c*. Therefore, the tubes **111** are also arranged at the pitch P1 in the direction perpendicular to the longitudinal direction of the tubes **111** along the header tank **120**. In the first embodiment, the first tank member **120***a* and the second tank member **120***b* have the same shape except that only the first tank member **120***a* has the through holes **123***a*. Therefore, the pitch P1 is set substantially equal to the pitch P2. As a result, when the first and second tank members **120***a*, **120***b* and the tubes **111** are brazed together to form the radiator **100**, each of the second protruding portions **124** is disposed opposite each of the connection portions **120***c*, that is, each of the tubes **111**.

Referring back to. FIG. **1**, an oil cooler **127** is accommodated in the second header tank **122** to cool engine oil or automatic transmission fluid. The oil cooler **127** has an oil inlet **128** through which oil is introduced therein and an oil outlet **129** through which oil is discharged. A side plate **140** is disposed at each of top and bottom ends of the core portion **110** in FIG. I to extend in a direction parallel with the longitudinal direction of the tubes **111** for reinforcing the core portion **110**. Further, as shown in FIGS. **2**–**3**C, each of the first and second tank members **120***a*, **120***b* has plural clamping portions **120***f*. Each of the clamping portions **120***f* of the first tank member **120***a* clamps the second tank member **120***b*, and each of the clamping portions **120***f* of the second tank member **120***b* clamps the first tank member **120***a*, so that the first and second tank members **120***a*, **120***b* are firmly brazed together.

According to the first embodiment, the second protruding portions **124** are formed at a non-connection portion of the header tank **120** connected with no tube **111**. The second protruding portions **124** are arranged in the direction perpendicular to the longitudinal direction of the tubes **111** along the header tank **120** at the pitch P2 substantially equal to the pitch P1 at which the connection portions **120***c* are arranged. Therefore, each of the second protruding portions **124** is disposed opposite each of the connection portions **120***c*. As a result, a rigidity of the non-connection portion of the header tank **120** is increased by the second protruding portions **124**, which are also regarded as first reinforcement ribs. Therefore, as shown in FIG. **5**, stress caused by an internal pressure of the header tank **120** is restricted from being intensively applied to the non-connection portion of the header tank **120**. As a result, a rigidity or a mechanical strength of the header tank **120** is increased without increasing a thickness of a metal plate from which the header tank **120** is formed, and a weight and a manufacturing cost of the radiator **100** are restricted from being increased. Further, the header tank **120** can be formed from material with a relatively small rigidity or a relatively small Young's modulus such as aluminum.

Further, since the first and second tank members **120***a*, **120***b* have the same shape except that only the first tank member **120***a* has the through holes **123***a*, the first and second tank members **120***a*, **120***b* are formed by pressing using the same die in processes prior to a process in which the through holes **123***a* are formed. Therefore, investment in plant and equipment for the radiator **100** is kept low. Furthermore, since the header tank **120** is formed by two parts, i.e., the first and second tank members **120***a*, **120***b*, the oil cooler **127** is readily inserted into the header tank **120**. Therefore, the number of manufacturing processes of the radiator **100** is decreased.

(Second Embodiment)

A second preferred embodiment of the present invention will be described with reference to FIGS. **6–10**. In this and following embodiments, components which are substantially the same as those in previous embodiments are assigned the same reference numerals.

In the second embodiment, as shown in FIG. **6**, the header tank **120** has plural second reinforcement ribs **130**. As shown in FIGS. **7–8**B, each of the second reinforcement ribs **130** is formed by plastically deforming a part of a corner portion **120***d* of the header tank **120** to protrude inside the header tank **120**. The second reinforcement ribs **130** prevent an interior angle θ of the corner portion **120***d* from increasing. As shown in FIG. **8**B, each of the second reinforcement ribs **130** is formed at the corner portion **120***d* between two of the tubes **111**, that is, at a position shifted from each of the tubes **111** in a longitudinal direction of the header tank **120**.

According to the second embodiment, as shown in FIG. **10**, the second reinforcement ribs **130** increase a rigidity of the corner portion **120***d* to which stress tends to be intensively applied. Therefore, the mechanical strength of the header tank **120** is increased without increasing a thickness of a metal plate from which the header tank **120** is formed. As a result, a weight and a manufacturing cost of the radiator **100** are restricted from increasing. Further, similarly to the first embodiment, the first and second tank members **120***a*, **120***b* are formed by pressing using the same die in processes prior to a process in which the through holes **123***a* are formed. Therefore, investment in plant and equipment for the radiator **100** is kept low.

(Third Embodiment)

A third preferred embodiment will be described with reference to FIGS. **11–13**. In the third embodiment, the longer-side wall **120***e* of the header tank **120** has plural third reinforcement ribs **131** which increase a rigidity of the longer-side wall **120***e*. The third reinforcement ribs **131** are formed to protrude outside the header tank **120**. As shown in FIG. **13**A, the third reinforcement ribs **131** are arranged in the direction perpendicular to the longitudinal direction of the tubes **111** along the header tank **120**, and are spaced at spacings P3 or P4 each of which is an integral multiple of the pitch P1.

According to the third embodiment, since a rigidity of the longer-side wall **120***e* is increased by the third reinforcement ribs **131**, the mechanical strength of the header tank **120** is increased without increasing a thickness of a metal plate from which the header tank **120** is formed. As a result, the weight and the manufacturing cost of the radiator **100** are restricted from increasing. Further, as shown in FIG. **12**, each of the third reinforcement ribs **131** is formed to continuously extend from a center of the longer-side wall **120***e* to both ends of the longer side **11**. Therefore, the mechanical strength of the header tank **120** is increased effectively. The center of the longer-side wall **120***e* means a center of a non-overlapped portion of the longer-side wall **120***e* in which the first and second tank members **120***a*, **120***b* are not overlapped.

When the number of the tubes **111** is increased or decreased to adjust a radiation capacity of the core portion **110**, a longitudinal length of the header tank **120** may need to be changed by cutting the header tank **120** depending on the number of the tubes **111**. According to the third embodiment, since each of the spacings P3 and P4 is set to an integral multiple of the pitch P1, each of the third reinforcement ribs **131** is disposed opposite any one of the tubes **111**. Therefore, when the header tank **120** is cut to be reduced in length, the header tank **120** is not cut at the third reinforcement ribs **131**. As a result, the header tank **120** formed using the same die can be used for a radiator core with various sizes, and the number of kinds of the die for the header tank **120** does not need to be increased. Therefore, investment in plant and equipment for the radiator **100** is kept low.

(Fourth Embodiment)

A fourth preferred embodiment of the present invention will be described with reference to FIGS. **15–16**C. The fourth embodiment is formed by combining the first through third embodiments. That is, as shown in FIGS. **15–16**C, the header tank **120** has the second protruding portions **124** as the first reinforcement ribs in the first embodiment, the second reinforcement ribs **130** in the second embodiment and the third reinforcement ribs **131** in the third embodiment. According to the fourth embodiment, the mechanical strength of the header tank **120** is further increased. In the third and fourth embodiments, the present invention is effectively applied to a radiator having a header tank with a rectangular cross-section.

(Fifth Embodiment)

A fifth preferred embodiment of the present invention will be described with reference to FIGS. **17–19**. In the fifth embodiment, as shown in FIGS. **17–19**, a radiator bracket **150** through which the radiator **100** is mounted to the vehicle is fastened to the side plate **140** by bolts **151**. The radiator bracket **150** has a pin **152** inserted into a vehicle bracket (not shown) attached to a vehicle, and insertion holes **153** into which the bolts **151** are respectively inserted. Each of the bolts **151** goes through each of the insertion holes **153** and each of bolt holes **141** formed in the side plate **140** and screws into a nut (not shown).

According to the fifth embodiment, even when a size of the radiator **100** is changed or an attachment position of the vehicle bracket to the vehicle is changed according to a vehicle model, the radiator **100** is readily mounted to the vehicle by replacing the radiator bracket **150**. In the fifth embodiment, the radiator bracket **150** may be fastened to the side plate **140** by screws each of which is screwed into a threaded hole formed in the side plate **140**. Further, the radiator bracket **150** may be brazed to the side plate **140**.

In the first embodiment, the header tank **120** may have a cross-section of any shape such as a circular cross-section, instead of a rectangular cross-section. Further, the present invention may be applied to any other heat exchangers such as a condenser instead of a radiator.

Although the present invention has been fully described in connection with preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A heat exchanger comprising:

a plurality of metal tubes through which fluid flows; and

a metal header tank disposed at a flow-path end of the tubes to extend in an extending direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes, the header tank including first and second walls opposite each other, the first wall having a plurality of connection portions each of which is connected to each of the tubes, the second wall having a plurality of first reinforcement ribs which increase a rigidity of the header tank, wherein:

the header tank substantially has a rectangular cross-section, and is constructed by connecting both a first tank member and a second tank member which have approximately the same shape;

the connection portions are arranged in the direction perpendicular to the longitudinal direction of the tubes at a first pitch;

the first reinforcement ribs are arranged in the direction perpendicular to the longitudinal direction of the tubes at a second pitch approximately equal to the first pitch; and

the first reinforcement ribs are provided on a surface of the second wall, opposite to the connection portions.

2. The heat exchanger according to claim **1**, wherein each of the first reinforcement ribs is disposed opposite each of the connection portions.

3. The heat exchanger according to claim **1**, wherein:

the header tank includes first and second longer-side walls opposite each other and first and second shorter-side walls opposite each other; and

the first and second walls are the first and second shorter-side walls, respectively.

4. The heat exchanger according to claim **3**, wherein the longer side of the rectangular cross-section is set to 40 mm and more and the shorter side of the rectangular cross-section is set to 35 mm and less.

5. A heat exchanger comprising:

a plurality of metal tubes through which fluid flows; and

a metal header tank disposed at a flow-path end of the tubes to extend in a direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes, the header tank including first and second walls opposite each other, the first wall having a plurality of connection portions each of which is connected to each of the tubes, the second wall having a plurality of first reinforcement ribs which increase a rigidity of the header tank, wherein:

the connection portions are arranged in the direction perpendicular to the longitudinal direction of the tubes at a first pitch;

the first reinforcement ribs are arranged in the direction perpendicular to the longitudinal direction of the tubes at a second pitch approximately equal to the first pitch; and

the header tank is formed by connecting a first tank member and a second tank member each of which is formed by pressing to have a L-shaped cross-section.

6. The heat exchanger according to claim **3**, wherein:

any one of the first and second longer-side walls and any one of the first and second shorter-side walls cross each other to form a corner portion; and

the header tank includes a second reinforcement rib disposed at the corner portion between adjacent two of the tubes in the extending direction to prevent an interior angle of the corner portion from increasing.

7. The heat exchanger according to claim **6**, wherein the header tank includes a third reinforcement rib disposed in the first and second longer-side walls for increasing a rigidity of the first and second longer-side walls.

8. The heat exchanger according to claim **3**, wherein the header tank includes a third reinforcement rib disposed in the first and second longer-side walls for increasing a rigidity of the first and second longer-side walls.

9. The heat exchanger according to claim **1**, wherein the first reinforcement ribs protrude inside the header tank.

10. The heat exchanger according to claim **9**, wherein the first reinforcement ribs are integrally formed by deforming a part of the header tank.

11. A heat exchanger comprising:

a plurality of metal tubes through which fluid flows; and

a metal header tank disposed at a flow-path end of the tubes to extend in an extending direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes, the header tank including two walls crossing each other to form a corner portion, and a first reinforcement rib disposed at the corner portion between adjacent two of the tubes in the extending direction to prevent an interior angle of the corner portion from increasing, wherein:

the header tank has a rectangular cross-section, and includes first and second longer-side walls opposite to each other and first and second shorter-side walls opposite to each other;

the first longer-side wall is crossed with the second shorter-side wall by a substantial right angle in the corner portion; and

the first reinforcement rib has a tilt surface connecting the first longer-side wall and the second shorter-side wall within the header tank, in an approximate triangular shape.

12. The heat exchanger according to claim **11**, wherein the header tank includes a second reinforcement rib disposed on the first and second longer-side walls for increasing a rigidity of the longer-side wall.

13. The heat exchanger according to claim **11**, wherein the first reinforcement rib protrudes inside the header tank.

14. The heat exchanger according to claim **13**, wherein the first reinforcement rib is integrally formed in the header tank by deforming a part of the corner portion to be recessed toward inside the header tank.

15. The heat exchanger according to claim **11**, wherein the corner portion extends in the direction perpendicular to the longitudinal direction of the tubes.

16. A heat exchanger comprising:

a plurality of metal tubes through which fluid flows; and

a metal header tank formed to have a rectangular cross-section having a longer side and a shorter side, and including a longer-side wall and a shorter-side wall, the header tank being disposed at a flow-path end of the tubes to extend in a direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes, the longer-side wall including a reinforcement rib which increases a rigidity of the longer-side wall, wherein:

the shorter-side wall has a plurality of connection portions into which the tubes are connected;

the header tank is constructed by connecting both a first tank member and a second tank member which approximately have the same shape.

17. The heat exchanger according to claim **16**, wherein the reinforcement rib protrudes outside the header tank.

18. The heat exchanger according to claim **17**, wherein the reinforcement rib is integrally formed by deforming a part of the longer-side wall.

19. The heat exchanger according to claim **16**, wherein:

the reinforcement rib includes a plurality of rib portions, the rib portions being arranged in the direction perpendicular to the longitudinal direction of the tubes;

the tubes are arranged in the direction perpendicular to the longitudinal direction of the tubes at a pitch;

a spacing between adjacent rib portions is an integral multiple of the pitch.

20. The heat exchanger according to claim **1**, wherein each of the first tank member and the second tank member has an approximate L-shaped cross-section.

21. The heat exchanger according to claim **11**, wherein the first reinforcement rib is disposed to protrude inside the header tank more than the flow-path end of the tubes.

22. The heat exchanger according to claim **11**, wherein the first reinforcement rib is disposed in each corner portion defined by the first and second longer-side walls and the first and second shorter-side walls.

23. A heat exchanger comprising:

a plurality of metal tubes through which fluid flows; and

a metal header tank disposed at a flow-path end of the tubes to extend in an extending direction perpendicular to a longitudinal direction of the tubes and to communicate with the tubes, the header tank having a rectangular cross-section with opposite first walls and opposite second walls, wherein:

one of the first walls has a plurality of connection portions into which the tubes are connected, the other one of the first walls has a plurality of first reinforcement ribs which increase a rigidity of the header tank;

the connection portions are arranged in the direction perpendicular to the longitudinal direction of the tubes at a first pitch;

the first reinforcement ribs are arranged in the direction perpendicular to the longitudinal direction of the tubes at a second pitch approximately equal to the first pitch; and

the header tank includes a second reinforcement rib provided on the second walls, for increasing a rigidity of the second walls.

24. The heat exchanger according to claim **23**, wherein each length of the second walls is longer than that of the first walls.

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